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18 February 1998

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS */

(Revision 2, including the amendments entered into force on 16 October 1995)

Addendum 26: Regulation No. 27

Revision 1

Incorporating:
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Supplement 1 to the 03 series of amendments - Date of entry into force: 18 January 1998

UNIFORM PROVISIONS FOR THE APPROVAL OF ADVANCE-WARNING TRIANGLES

UNITED NATIONS

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*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

GE.98-20442

Regulation No. 27

UNIFORM PROVISIONS FOR THE APPROVAL OF ADVANCE-WARNING TRIANGLES

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1. SCOPE

This Regulation applies to certain advance-warning devices intended to be on board vehicles and to be placed on the carriageway in order to signal, by day and at night, the presence of a halted vehicle.

2. DEFINITIONS

For the purposes of this Regulation,

2.1. "Advance-warning triangle" means the device referred to in paragraph 1 above, and in the form of an equilateral triangle;

2.2. "Type of triangle" means advance-warning triangles which do not differ in such essential respects as:

2.2.1. the trade name or mark;

2.2.2. the optical characteristics;

2.2.3. the distinctive geometrical and mechanical features of the design;

2.3. "Retro-reflecting device" means an assembly, ready for use, comprising one or more retro-reflecting optical units;

2.4. "Front face of the triangle" means the face carrying the optical units;

2.5. "Axis of the advance-warning triangle" means the straight line which, perpendicular to the front face of the triangle, passes through its centre;

2.6. "Fluorescent material" means a material which, either in the mass or at the surface, when excited by daylight, exhibits the phenomenon of photo-luminescence ceasing rather shortly after excitation;

2.7. "Luminance factor" means the ratio of the luminance of the body considered to the luminance of a perfect diffuser under identical conditions of illumination and observation. The luminance of the body considered includes that produced by reflection and by fluorescence;

2.8. "Coefficient of luminous intensity (CIL)" means the amount of luminous intensity reflected in the direction considered, divided by the illumination of the retro-reflecting device for given angles of illumination, divergence and rotation. The illumination is measured in a plane normal to the direction of the incident light.

3. APPLICATION FOR APPROVAL

The application for approval shall be submitted by the holder of the trade name or mark or by his duly accredited representative, and shall be accompanied by:

3.1. Dimensional drawings in triplicate in sufficient detail to permit identification of the type;

3.2. A brief description giving the technical specifications of the materials constituting the advance-warning triangle and instructions for use;

3.3. A copy of the instructions on its assembly for use;

3.4. Four samples of the advance-warning triangle and at least two protective covers if the advance-warning triangles are to be supplied with protective covers;

3.5. Two samples of the fluorescent material in which a 100 x 100 mm square can be inscribed and which are fully representative of the material applied under the same conditions to the same base material as used for the advance-warning triangle.

4. MARKINGS

4.1. Every advance-warning triangle and its protective cover shall, when submitted for approval, bear the trade name or mark of the applicant; such marking shall be clearly legible and be indelible.

4.2. Every advance-warning triangle and its protective cover shall provide adequate space for the approval mark; the space aforesaid shall be shown in the drawings referred to in paragraph 3.1. above.

5. APPROVAL

5.1. If all the samples of a type of advance-warning triangle which are submitted in conformity with the provisions of paragraph 3 above meet the requirements of this Regulation, approval shall be granted.

5.2. The approval number shall be assigned to each type approved. Its first two digits (at present 03 corresponding to the 03 series of amendments which entered into force on 3 March 1985) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another type of advance warning triangle covered by this Regulation.

5.3. Notice of approval or of refusal of approval of a type of advance-warning triangle pursuant to this Regulation shall be communicated

to the countries Parties to the Agreement which apply this Regulation by means of a form conforming to the model in annex 1 to this Regulation accompanied by dimensional drawings (supplied by the applicant for approval) in a format not exceeding A 4 (210 x 297 mm), or folded to that format, and on an appropriate scale.

5.4. In addition to the markings prescribed in paragraph 4.1. above, there shall be affixed, in the space referred to in paragraph 4.2. above, to every advance-warning triangle and to its protective cover conforming to a type approved under this Regulation:

5.4.1. An international approval mark consisting of:

5.4.1.1. a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval; 1/

5.4.1.2. the number of this Regulation, followed by the letter "R" and the approval number prescribed in paragraph 5.2. above. The figures and letters shall face the same way as the letter "E".

5.5. The trade name or mark on the protective cover shall be visible from the outside.

5.6. The approval mark shall be clearly legible and indelible.

5.7. Annex 2 to this Regulation gives examples of the arrangement of the approval mark.

6. GENERAL SPECIFICATIONS

6.1. The advance-warning triangle shall be open at the centre and shall comprise a red border composed of an outer retro-reflecting strip and an inner fluorescent strip, the whole supported at a certain height above the surface of the carriageway. The open centre and the fluorescent and retro-reflecting strips shall be bounded by concentric equilateral triangular contours.

1/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech Republic, 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15 (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal, 22 for the Russian Federation, 23 for Greece, 24 (vacant), 25 for Croatia, 26 for Slovenia, 27 for Slovakia, 28 for Belarus, 29 for Estonia, 30 (vacant), 31 for Bosnia and Herzegovina, 32-36 (vacant) and 37 for Turkey. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement concerning the Recognition of Approval for Motor Vehicle Equipment and Parts, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

6.2. Advance-warning triangles shall be so made that in normal use (on the road and when carried in the vehicle) they retain the prescribed characteristics and their satisfactory functioning continues to be ensured.

6.3. The optical units of the advance-warning triangle shall not be easily disassembled. The various parts making up the advance-warning triangle shall provide good stability on the road. They shall not be easily disassembled. If a triangle has to be folded in order to be placed in its protective cover, the movable parts, including its supports, shall not be detachable.

6.4. When the advance-warning triangle is in the position of use on the road, the front face of the triangle must be vertical. This condition is deemed fulfilled if the axis of the triangle does not form an angle of more than 5° with the base plane.

6.5. The front face of the advance-warning triangle shall be easy to clean; in particular, it shall not be rough, and such protuberances as it may exhibit shall not prevent such cleaning.

6.6. The advance-warning triangle and its support shall not present sharp edges or corners.

6.7. The advance-warning triangle shall be accompanied by its protective cover, if any, against external agents, especially during carriage; it may however be supplied without protective cover where the necessary protection is provided by other means. These means shall be stated in the description mentioned in paragraph 3.2. above and in the communication form under paragraph 5.3 of this Regulation.

6.8. Each triangle shall be required to be accompanied by a copy of the instructions referred to in paragraph 3.3. above.

7. PARTICULAR SPECIFICATIONS

7.1. Requirements as to shape and dimensions

7.1.1. Shape and dimensions of the triangle (see annex 3)

7.1.1.1 The theoretical sides of the triangle shall be 500 ± 50 mm long.

7.1.1.2. The retro-reflecting units shall be arranged along the edge within a strip of an unvarying width which shall be between 25 mm and 50 mm.

7.1.1.3 Between the outer edge of the triangle and the retro-reflecting strip there may be an edging not more than 5 mm wide and not necessarily red-coloured.

7.1.1.4. The retro-reflecting strip may be continuous or not. In the latter case the free area of the supporting material must be red (see also paragraph 7.3.1.2. of this Regulation.

7.1.1.5. The fluorescent surface shall be contiguous to the retro-reflecting units. It shall be arranged symmetrically along the three sides of the triangle. When in use, its surface area shall be not less than 315 cm^2. However, an edging, continuous or not, not more than 5 mm wide, which need not necessarily be red-coloured, may be placed between the retro-reflecting surface and the fluorescent surface.

7.1.1.6. The side of the open centre of the triangle shall have a minimum length of 70 mm (fig. 1).

7.1.2. Shape and dimensions of the support

7.1.2.1. The distance between the supporting surface and the lower side of the advance-warning triangle shall not exceed 300 mm.

7.2. Colorimetric specification

7.2.1. Retro-reflecting devices

7.2.1.1. Retro-reflecting devices shall be made of material coloured red in the mass.

7.2.1.2. When the retro-reflecting device is illuminated by the CIE standard illuminant A, with an angle of divergence of 1/3° and an illumination angle V = H = 0°, or, if this produces a colourless surface reflection, an angle V = ± 5°, H = 0°, the trichromatic co-ordinates of the red reflected luminous flux shall be within the following limits:

limit towards yellow $y \leq 0.335$
limit towards purple $z \leq 0.008$

7.2.1.3. The testing of the colour shall be carried out according to the method described in annex 5, paragraph 2.1.

7.2.2. Fluorescent materials

7.2.2.1. The fluorescent materials shall either be coloured in the mass or take the form of separate coatings applied to the surface of the triangle.

7.2.2.2. When the fluorescent material is illuminated by the CIE standard illuminant C the trichromatic co-ordinates of the light reflected and emitted by the fluorescence shall be within an area of which the corner points are determined by the following co-ordinates (the angle of illumination being 45° and the observation being made at an angle of 90° to the sample (45°/0° measuring geometry)):

Point	1	2	3	4
x	0.690	0.595	0.569	0.655
y	0.310	0.315	0.341	0.345

7.2.2.3. The testing of the colour shall be carried out according to the method described in annex 5, paragraph 2.2.

7.3. Photometric specifications

7.3.1. Retro-reflecting devices

7.3.1.1. The values of the CIL of retro-reflecting optical units shall be not less than those given in the table below, expressed in millicandelas per lux, for the angles of divergence and the illumination angle shown:

		Illumination angles β			
Vertical V (β_1) Horizontal H (β_2)		0° 0° or ± 5°	± 20° 0°	0° ± 30°	0° ± 40°
Angles of divergence α	20'	8,000	4,000	1,750	600
	1°30'	600	200	100	50

7.3.1.2. The CIL measured on random slices of 50 mm length of the retro-reflecting device shall lie between extremes having a ratio not in excess of 3. These slices are taken between the perpendiculars to the side of the triangle and passing through the corresponding apexes of the central aperture. This requirement applies to an angle of divergence of 20' and to illumination angles of V = 0°, H = 0° or ± 5° and V = ± 20°, H = 0°.

7.3.1.3. Diversity of luminance at angles of illumination of V = 0°, H = ± 30°, and V = 0°, H = ± 40° shall be tolerated on condition that the triangular shape remains clearly discernible, for an angle of divergence of 20' and an illumination of approximately 1 lux.

7.3.1.4. The measurements referred to above shall be performed by the method described in annex 5 to this Regulation, paragraph 4.

7.3.2. Fluorescent materials

7.3.2.1. The luminance factor including the luminance by reflection and fluorescence, shall not be less than 30 per cent.

7.3.2.2. The measurement of the luminance factor shall be carried out according to the method described in annex 5, paragraph 3.

8. TEST PROCEDURE

Every advance-warning triangle and its protective cover, if any, shall meet the requirements of the checks and tests described in annex 5 to this Regulation.

9. MODIFICATIONS OF THE ADVANCE-WARNING TRIANGLE TYPE AND EXTENSION OF APPROVAL

9.1. Every modification of the triangle type shall be notified to the administrative department which granted approval. The department may then either:

9.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect, and that in any case the triangle still meets the requirements; or

9.1.2. require a further report from the technical service responsible for conducting the tests.

9.2. Notice of confirmation of approval, specifying the modifications, or of refusal of approval shall be communicated by the procedure specified in paragraph 5.3. above to the Parties to the Agreement which apply this Regulation.

9.3. The competent authority issuing the extension of approval shall assign a series number to each communication form drawn up for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 1 to this Regulation.

10. CONFORMITY OF PRODUCTION

The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2), with the following requirements:

10.1. Advance-warning triangles approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 6, 7 and 8 above.

10.2. In addition, the stability in time of the optical properties and colour of retro-reflecting optical units of advance-warning triangles conforming to an approved type and in use shall be verified. In the event of a systematic deficiency of the retro-reflecting optical units of advance-warning triangles in use and conforming to an approved type, approval may be withdrawn. A "systematic deficiency" shall be deemed to exist where an approved type of advance-warning triangle fails to meet the requirements of paragraph 6.2. of this Regulation.

10.3. The minimum requirements for conformity of production control procedures set forth in annex 7 to this Regulation shall be complied with.

10.4. The minimum requirements for sampling by an inspector set forth in annex 8 to this Regulation shall be complied with.

10.5. The authority which has granted type approval may at any time verify the conformity control methods applied in each production facility. The normal frequency of these verifications shall be once every two years.

11. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

11.1. The approval granted in respect of a type of advance-warning triangle may be withdrawn if the foregoing requirements are not complied with.

11.2. If a Contracting Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith notify the other Contracting Parties applying this Regulation thereof by means of a communication form conforming to the model in annex 1 to this Regulation.

12. PRODUCTION DEFINITELY DISCONTINUED

If the holder of the approval completely ceases to manufacture a device under this Regulation, he shall inform thereof the authority which granted the approval. Upon receiving the relevant communication that authority shall inform the other Parties to the Agreement which apply this Regulation thereof by means of a communication form conforming to the model in annex 1 to this Regulation.

13. NAMES AND ADDRESSES OF TECHNICAL SERVICES CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENT

The Contracting Parties to the Agreement applying this Regulation shall communicate to the secretariat of the United Nations the names and addresses of the technical services conducting approval tests and of the administrative departments which grant approval and to which the forms certifying approval or refusal or withdrawal of approval, issued in other countries, are to be sent.

Annex 1

COMMUNICATION

(maximum format: A4 (210 x 297 mm))

issued by: Name of administration:
.....
.....
.....

concerning: 2/ APPROVAL GRANTED
APPROVAL EXTENDED
APPROVAL REFUSED
APPROVAL WITHDRAWN
PRODUCTION DEFINITELY DISCONTINUED

of a type of advance-warning triangle pursuant to Regulation No. 27.

Approval No.: ..... Extension No.: .....

1. Trade name or mark of the advance-warning triangle . . . . . .
2. Manufacturer's name . . . . . .
3. Address . . . . . .
4. If applicable, name of manufacturer's representative . . . . . .
5. Address . . . . . .
6. Brief description of the advance-warning triangle . . . . . .
7. Submitted for approval on . . . . . .
8. Technical service conducting approval tests . . . . . .
9. Date of report issued by that service . . . . . .
10. Number of report issued by that service . . . . . .
11. Approval granted/extended/refused/withdrawn 2/
12. Remarks . . . . . .
13. Place . . . . . .

14. Date . . . . . .

15. Signature . . . . . .

16. The following documents, bearing the approval number shown above, are annexed to this communication:

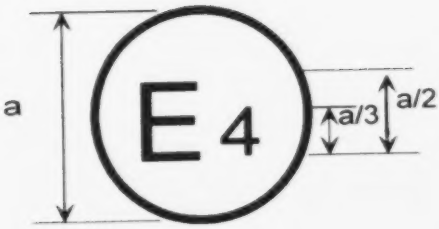
..... dimensioned drawings
..... photographs

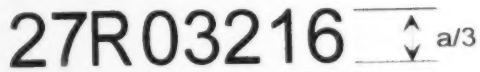
1/ Distinguishing number of the country which has granted/extended/refused or withdrawn approval (see footnote 1/ to paragraph 4.4.1.).

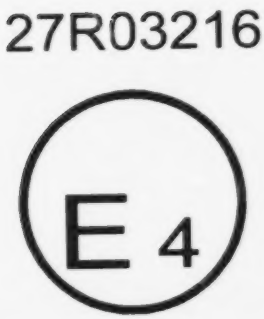
2/ Strike out what does not apply.

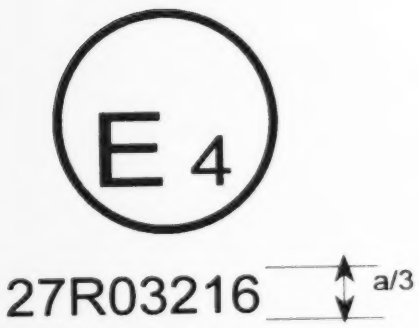
Annex 2

ARRANGEMENTS OF THE APPROVAL MARK









a ≥ 8 mm

An advance-warning triangle bearing one of the approval marks shown above has been approved in the Netherlands (E4) under approval number 03216. The first two digits of the approval number indicate that the approval was granted according to the requirements of this Regulation as amended by the 03 series of amendments.

Note: The drawings show several possible embodiments and are given by way of example. The competent authorities shall avoid using Roman numerals for the approval, in order to prevent any confusion with other symbols.

Annex 3

Figure 1: SHAPE AND DIMENSIONS OF THE ADVANCE-WARNING TRIANGLE AND OF THE SUPPORT

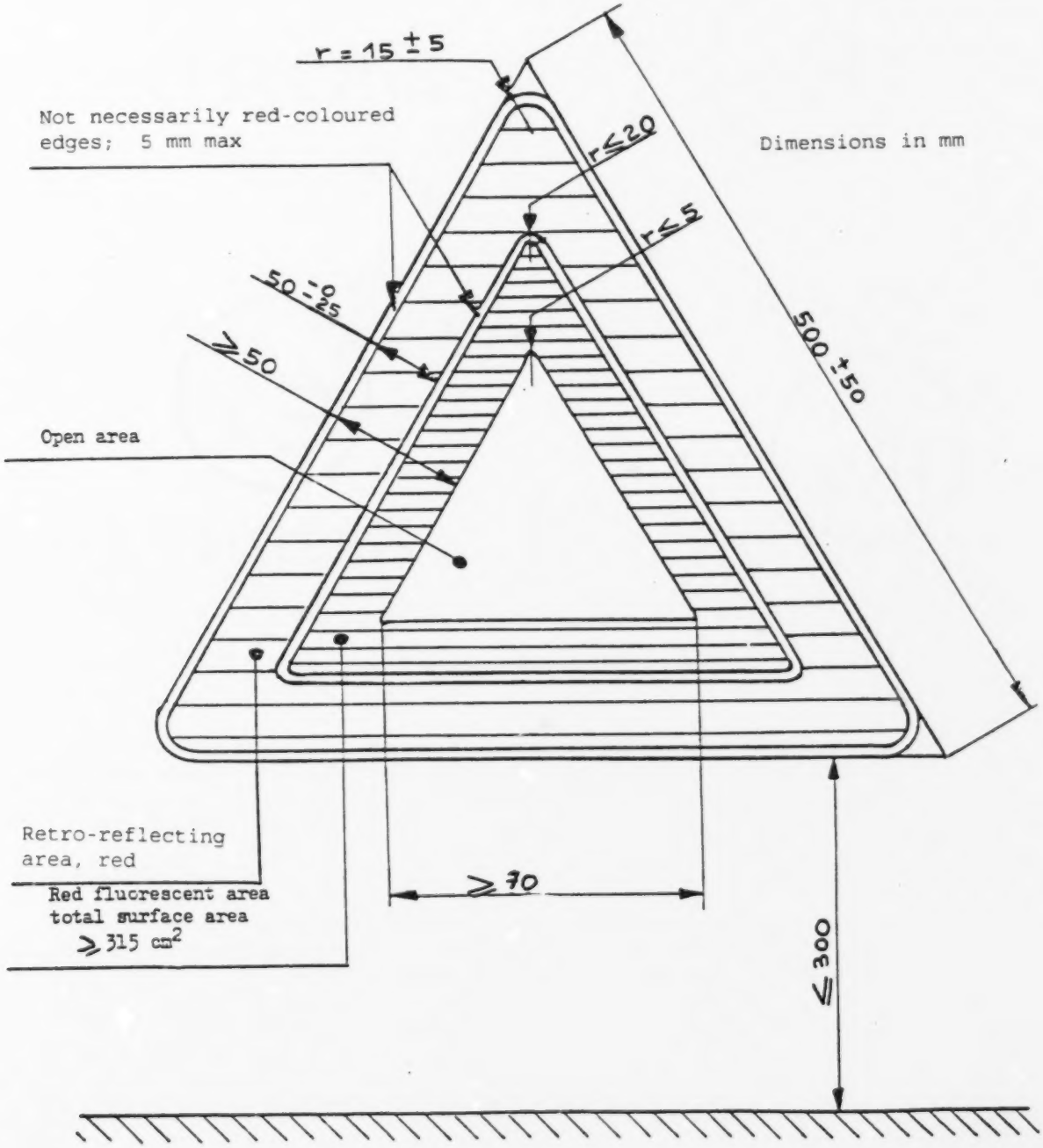
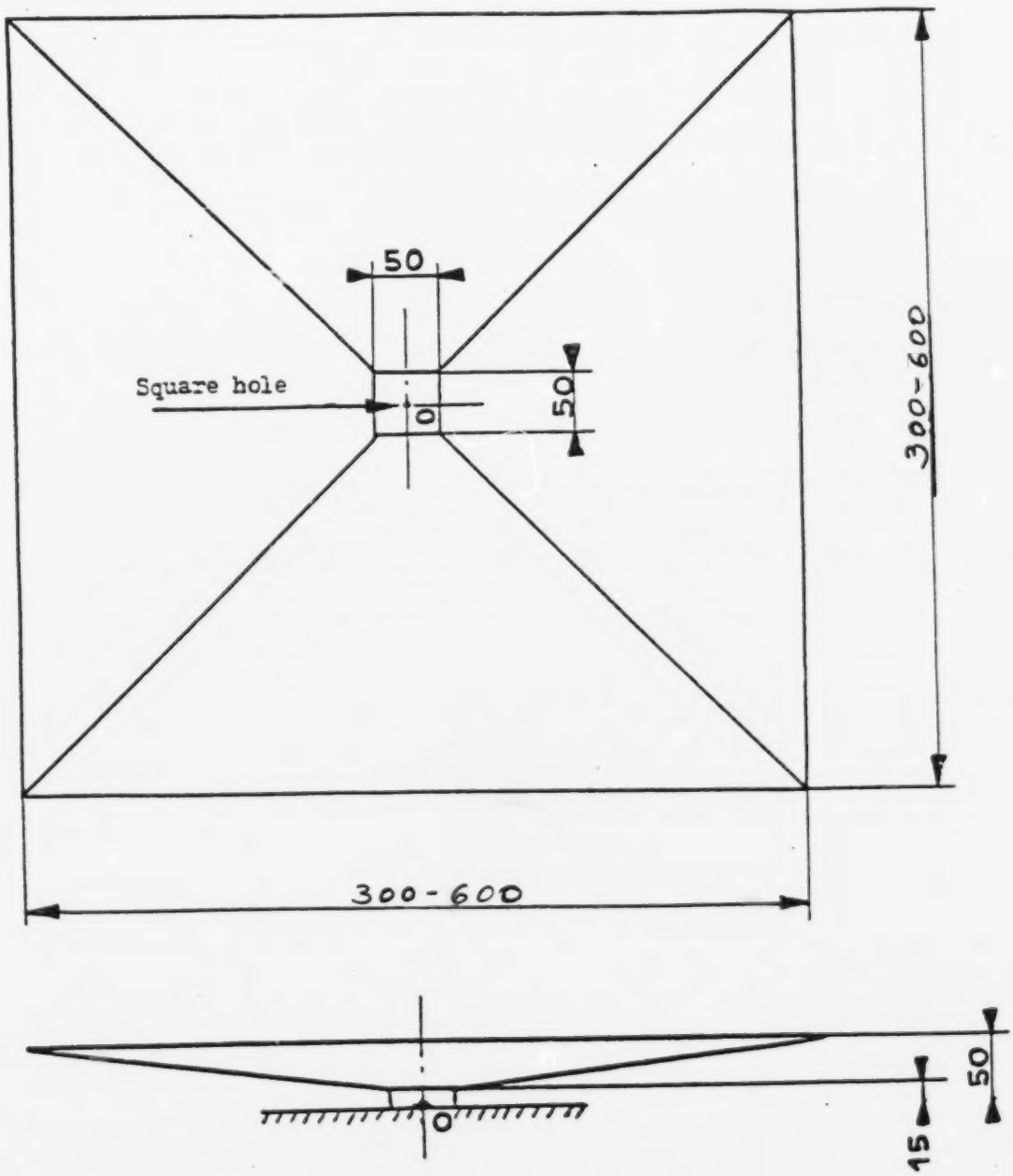


Figure 2: TEST DEVICE FOR CLEARANCE TO GROUND



Dimensions in mm

Annex 4

DETERMINATION OF THE ROUGHNESS OF THE ROAD SURFACE "SANDY BEACH" METHOD

1. Purpose of the method

1.1. The purpose of this method is to describe and to determine to a certain extent the geometric roughness of that part of the road surface on which the advance-warning triangle is placed during the test of stability in wind, as required according to annex 5, paragraph 10.

2. Principle of the method

2.1. A known volume V of sand is spread evenly on the surface of the carriageway in the form of a circle. The ratio of the volume used to the area S covered is defined as "mean sand depth" HS and is expressed in mm:

$$HS = \frac{V}{S}$$

2.2. The test is carried out by means of round-grain, dry sand and having a grain size between 0.160 mm and 0.315 mm. The volume amounts to 25 ml ± 0.15 ml. The sand is spread out over the surface where the test is carried out by means of a flat, circular disc with a diameter of 65 mm, one side of which is covered with a sheet of rubber having a thickness of 1.5 mm to 2.5 mm and the other being provided with an appropriate handle. If the diameter of the circular area covered with sand is D mm, the mean sand depth will be calculated in accordance with the formula:

$$HS = \frac{4}{\pi} \cdot \frac{25}{D^2} \cdot 10^3 \ mm$$

3. Performance of the test

3.1. The surface on which the test is to be carried out must be dry and at first be brushed with a soft brush to remove any dirt or loose gravel.

3.2. The sand which has been firmly filled into an appropriate receptacle is then poured out on the surface to be tested in a single heap. The sand is then carefully spread out on the surface by means of repeated circular movements of the rubber faced disc so as to form the largest possible round area covered with sand. The sand will then fill all depressions and hollows.

3.3. Two diameters, at right angles to one another, of the "beach" thus formed are usually measured. The mean value is rounded off to the nearest 5 mm, with the depth of the sand HS being calculated according to the formula given in paragraph 2.2.

3.4. Six tests of this kind are carried out on the supporting surface, with the parts to be tested being distributed over the surface to be tested as evenly as possible. The overall mean of the results obtained is given as the mean sand depth HS of the road surface where the advance-warning triangle has been placed.

Annex 5

TEST PROCEDURES

1. General

1.1. The applicant shall submit samples, as mentioned in paragraphs 3.4. and 3.5. of this Regulation, for approval.

1.2. After verification of the general specifications (paragraph 6 of the Regulation) and the specifications of shape and dimensions (paragraph 7.1. of this Regulation), all samples shall be subjected to the heat resistance test (paragraph 7 below) and examined after at least one hour of rest.

1.3. The CIL value of the four samples of the advance-warning triangles submitted is measured at an observation angle of 20' and at an illumination angle with the components V = 0°, H = ± 5°; this test is carried out in accordance with the method described in paragraph 4 below.

1.4. The two triangles which show the smallest and the largest CIL value during the tests carried out according to paragraph 1.3. above shall be visually compared, during daylight and at a distance of 30 m by an observer having normal colour response, with the two samples submitted in accordance with paragraph 3.5. of this Regulation. There shall be no noticeable difference in colour or luminance between the fluorescent material on the four samples.

1.5. The same two samples with the smallest and the largest CIL value in the tests according to paragraph 1.4. above shall be subsequently subjected to the following tests:

1.5.1. Measurement of the values of the CIL in respect of the observation and illumination angles referred to in paragraphs 7.3.1.1. and 7.3.1.2. of this Regulation according to the method described in paragraph 4 below. The visual inspection as meant in paragraphs 7.3.1.3. and 7.3.1.4. of this Regulation can then also be performed.

1.5.2. Testing of the colour of the retro-reflected light according to paragraph 2.1. below on the sample which, as a result of a visual inspection, seems to have the least favourable colorimetric characteristics; in other cases the sample with the highest CIL concerned shall be examined.

1.5.3. Test of clearance to ground according to paragraph 5 below.

1.5.4. Mechanical solidity test according to paragraph 6 below.

1.6. One sample other than those referred to in paragraph 1.5. below shall be subjected to the following tests:

1.6.1. Testing of resistance to penetration of water into the retro-reflecting device according to paragraph 11.1. below or if relevant, of the mirror-backed reverse side of the retro-reflecting device, according to paragraph 11.2. below.

1.7. The second sample, other than those referred to in paragraph 1.5. above, shall be subjected to the following tests:

1.7.1. Water test according to paragraph 8 below.

1.7.2. Testing of resistance to fuels according to paragraph 9 below.

1.7.3. Test of stability against wind according to paragraph 10 below.

1.8. After the tests specified in paragraph 1.5. above, the two samples submitted according to paragraph 3.5. of this Regulation shall be subjected to the following tests:

1.8.1. Colour test according to paragraph 2.2. below.

1.8.2. Test of the luminance factor according to paragraph 3 below.

1.8.3. Test of weather resistance according to paragraph 12 below.

2. Colour tests

2.1. Colour of retro-reflecting devices

2.1.1. The colour of the retro-reflecting devices to be tested according to paragraph 7.2.1. of this Regulation may be ascertained visually by observers having normal colour-response, by means of comparison with coloured lights the trichromatic co-ordinates of which is adequately within the colour limits defined in paragraph 7.2.1.2. of this Regulation.

2.1.2. If any doubt remains after this test, compliance with the colorimetric specifications shall be verified by determining the trichromatic co-ordinates of the most doubtful sample.

2.2. Colour of the fluorescent material

2.2.1. The colour of the fluorescent material to be tested according to paragraph 7.2.2. of this Regulation may be ascertained visually by observers having normal colour-response, by comparison with fluorescent materials the trichromatic co-ordinates of which is adequately within the colour limits defined in paragraph 7.2.2.2. of this Regulation. The illumination and observation of the samples shall be carried out in the measuring geometry 45°/0°, and illuminance shall be chosen so as to ensure photopic vision.

2.2.2 If any doubt remains after this test, compliance with the colorimetric specification shall be verified by determining the trichromatic co-ordinates of the most doubtful sample.

3. Determination of the luminance factor of the fluorescent material

3.1. For the determination of the luminance factor the sample shall be illuminated by a light source of the CIE illuminant C, at an angle of illumination of 45° to the normal, and the light emitted by luminosity and reflection observed in the direction of the normal (geometry 45°/0°) shall be measured. The luminance factor may be obtained:

3.1.1 By putting the luminance L of the sample into relation to the luminance L_O of a perfect diffuser whose luminance factor β_O is known under identical conditions of illumination and observation; the luminance factor β of the sample then results from the formula:

$$\beta = \frac{L}{L_O} \cdot \beta_O$$

3.1.2. When the colour of the fluorescent material has been colorimetrically determined in compliance with paragraph 2.2.2. above, from the ratio of the tristimulus value Y the sample and the tristimulus value of the perfect diffuser Y_O; in this case it is:

$$\beta = \frac{Y}{Y_O}$$

4. Measurement of the value of the CIL of retro-reflecting devices

4.1. For this measurement it is assumed that the direction of illumination $H = V = \theta$ for the advance-warning triangle in its position of use is parallel to the base plane and vertical to the lower side of the triangle, which in turn is parallel to the said base plane.

4.2. The measurement shall be performed by the method described in annex 6 to this Regulation.

5. Test of clearance to ground

5.1. The advance-warning triangle shall be required to pass the following tests:

5.1.1. For this test, the apparatus shown in annex 3, figure 2, of this Regulation, which has the form of an inverted hollow pyramid, shall be placed on a horizontal base plane.

5.1.2. The individual supports to the ground shall be placed one after another in the square hole σ of the test apparatus. During the test of each support, it shall be required to find a position of the test apparatus in relation to the advance-warning triangle and its supporting device, which is favourable for the triangle and which ensures that:

5.1.2.1. all supports are resting simultaneously on the base plane,

5.1.2.2. outside the area covered by the test apparatus, the distance between the base plane and parts of the triangle as well as of the supporting device is at least 50 mm (with the exception of the supports proper).

6. Mechanical solidity test

6.1. When the advance-warning triangle has been set up as required by the manufacturer and its bases are firmly held, a force of 2 N shall be applied to the apex of the triangle parallel to the supporting surface and normal to the lower side of the triangle.

6.2. The apex of the triangle shall not move more than 5 cm in the direction in which the force is exerted.

6.3. After the test, the position of the device shall not be significantly different from its original position.

7. Test of heat and low-temperature resistance

7.1. The advance-warning triangle, in its protective cover, if provided, shall be kept for 12 consecutive hours in a dry atmosphere at a temperature of 60°C ± 2°C.

7.2. After the test, no cracking or noticeable distortion of the device shall be visible; this applies in particular to the retro-reflecting device. The cover shall be readily openable and shall not adhere to the triangle.

7.3. After the heat-resistance test and subsequent storage for 12 consecutive hours at a temperature of 25°C ± 5°C, the advance-warning triangle, in its protective cover, is to be kept for another 12 hours in a dry atmosphere at a temperature of -40°C ± 2°C.

7.4. Immediately after removal from the cold room, no fractures or any visible distortion shall be noticeable on the device and especially on its optical parts. The protective cover, if provided, shall be properly openable, and it shall neither tear nor adhere to the advance-warning triangle.

8. Water test

The triangle - collapsible advance-warning triangles are to be assembled as for use - shall be immersed flat for two hours on the bottom of a tank containing water at 25°C ± 5°C, with the active face of the triangle showing upwards and being 5 cm under the surface of the water. The triangle shall then be removed and dried. No part of the device may exhibit clear signs of deterioration which might impair the effectiveness of the triangle.

9. Test of resistance to fuels

The triangle and its protective cover shall be immersed separately in a tank containing a mixture of 70 per cent n-heptane and 30 per cent toluene. After 60 seconds they shall be removed from the tank and drained of excess liquid. The triangle shall then be placed in its cover and the unit shall be laid flat in a still atmosphere. When completely dried, the triangle shall not adhere to its protective cover, and there shall be no visually noticeable change on its surface and shall not present apparent detrimental modifications; however, slight surface cracks may be tolerated.

10. Test of stability against wind

10.1. The advance-warning triangle shall be set up in a wind tunnel, on a base measuring about 1.50 m by 1.20 m formed of a road surface as normally used by the competent authorities. This surface shall be characterized by its geometric roughness HS = 0.5 mm ± 0.05 mm, which shall be defined and determined by the so-called "sandy beach" method according to annex 4 of this Regulation.

10.2. When set up in this manner, the advance-warning triangle shall be subjected for 3 minutes to an air stream exerting a dynamic pressure of 180 Pa (about 60 km/h under normal conditions) parallel to the supporting surface, in a direction which seems to be most unfavourable for the stability.

10.3. The advance-warning triangle shall:

10.3.1. neither overturn,

10.3.2. nor shift. Slight shifting of the points of contact with the road surface by not more than 5 cm, however, shall be allowed.

10.4. The triangular part of the device shall not rotate through more than 10° round a horizontal axis or a vertical axis from its initial position.

11. Test of resistance of the retro-reflecting device

11.1. Test of resistance to penetration of water

11.1.1. The triangle - collapsible triangles are to be assembled as for use - shall be immersed for 10 minutes in water having a temperature of 50° ± 5°C, with the highest point of the upper part of the illuminating surface being about 20 mm below the water surface. Immediately afterwards, this retro-reflecting device shall be immersed under the same conditions in water having a temperature of 25°C ± 5°C.

11.1.2. After this test, no water shall have penetrated to the reflecting surface of the retro-reflecting device. If a visual inspection clearly reveals the presence of water, the device has not passed the test.

11.1.3. If the visual inspection does not reveal the presence of water, or in case of doubt the value of the CIL shall again be measured under the same conditions as specified in paragraph 1.2. above, after the retro-reflecting device has been gently shaken to remove excess water from the outside. The CIL shall not have diminished by more than 40 per cent of the values recorded before the test.

11.2. Test of resistance of the accessible reverse side of the mirror-backed retro-reflecting device

The reverse side of the retro-reflecting device shall be brushed with a hard nylon brush and then covered or thoroughly wetted for one minute with a mixture of 70 per cent n-heptane and 30 per cent toluene. The fuel shall then be removed and the device allowed to dry. As soon as evaporation is completed, the reverse side shall be brushed with the same brush as before. The value of the CIL shall then be measured under the same conditions as specified in paragraph 1.2. above, after the whole surface of the mirror-coated reverse side has been covered with Indian ink. The CIL shall not have diminished by more than 40 per cent of the values recorded before the test.

12. Test of the weather-resistance of the luminance factor and of the colour of the fluorescent material

12.1. One of the samples of the fluorescent material submitted according to paragraph 3.5. of this Regulation shall be subjected to a temperature and irradiation test described in ISO 105 of 1978 until the contrast No. 4 of the grey scale has been reached for the reference sample No. 5.

12.2. After this test, the colour co-ordinates of the fluorescent material shall comply with colour specification in paragraph 7.2.2.2. of this Regulation. The luminance factor (see

paragraph 3 above) shall be at least 30 per cent and shall not have increased by more than 5 per cent compared with the value ascertained according to paragraph 1.8.2. above.

12.3. The sample shall not exhibit any visible damage such as cracks, scaling or peeling of the fluorescent material.

12.4. If the fluorescent material is an adhesive film which had already successfully passed the above-mentioned tests in a previous approval test, the test need not be repeated; a corresponding note shall be entered under item 12 ("Remarks") in the communication concerning approval (annex 1 of this Regulation).

Annex 6

METHOD FOR MEASUREMENT OF THE CIL OF THE RETRO-REFLECTING DEVICE

1. DEFINITIONS

Needed definitions are explained by figures 1 to 4.

2. DIMENSIONAL AND PHYSICAL SPECIFICATIONS FOR THE PHOTOMETRY OF RETRO-REFLECTORS

2.1. The CIE-angular system as shown in figure 1 shall be used.

An adequate support (goniometer) is demonstrated in figure 2.

2.2. The measuring distance shall be chosen in such an order that at least the limits for the angles δ, γ and η given in figure 4 are respected, but not lower than 10 m or its optical equivalent.

2.3. The illuminance at the retro-reflector

The illuminance over the useful area of the retro-reflector, measured perpendicular to the incident light shall be sufficiently uniform. A check on this condition requires a measuring element, the sensitive area of which is not greater than one-tenth of the area to be examined. The variation in the value of the illuminance shall then comply with the condition:

$$\frac{maximum\ value}{minimum\ value} \leq 1.05$$

2.4. The colour temperature and the spectral distribution of the source

The source used for illuminating the retro-reflector shall as faithfully as possible represent the CIE illuminant A, both as regards colour temperature and spectral power distribution.

2.5. The photometer head (measuring element)

2.5.1. The photometer head shall be corrected to the spectral luminous efficiency for the CIE standard photometric observer in photopic vision.

2.5.2. The device shall not show a perceptible change in local sensitivity within the area of its aperture; otherwise suitable provisions must be added, e.g. the application of a diffusing window at a certain distance in front of the sensitive surface.

2.5.3. Experience has shown that non-linearity of photometer heads may be a problem with the very small light quantities which are the

rule in the photometry of retro-reflectors. A check at comparable illuminance levels on the photometer head is recommended.

2.6. The influence of a regular reflection

The amount and distribution of the regular reflection from the surface of the retro-reflector depends on the flatness and the gloss of the surface. In general, regular reflection is best avoided when the reference axis is placed so that the regular reflection is directed on the opposite side of the source from the photometer head (for example with $\beta_1 = -5°$).

3. MEASUREMENT PRECAUTIONS IN THE PHOTOMETRY OF RETRO-REFLECTION

3.1. Residual and stray light

3.1.1. Since very low light levels are to be measured special precautions are needed to minimize errors due to stray light. The background to the sample and the framework of the sample holder should be matt black and the field of view of the photometer head and the spread of light from both the sample and the source should each be restricted as much as possible.

3.1.2. Reflections from the floor and walls which occur over the relatively long test distances used must be screened from both the sample and the photometer head by baffles. The importance of looking from the photometer head to check for sources of stray light cannot be over emphasized.

3.1.3. A valuable aid to reducing the amount of stray light in the laboratory is to use a slide projector type of optical system for the light source. With this, an iris diaphragm or suitable sized apertures may be used in the optical system to restrict the illuminated area at the sample to the minimum size needed to provide uniform illuminance over the sample.

3.1.4. Residual stray light should always be allowed for by measuring it when the sample is covered by an opaque matt black surface, zig-zag folded black paper of the same size and shape or a specular black surface suitably oriented with a light trap. This value should be subtracted from that measured on the retro-reflector.

3.2. Stability of the apparatus

3.2.1. The light source and photometer head should remain stable throughout the period of the test. Since the sensitivity and the adaptation to the V (λ) function of most photometer heads change with temperature, the laboratory ambient temperature should not vary significantly during this period. Sufficient time should always be allowed for the apparatus to stabilize before commencing measurements.

3.2.2 The power supply to the light source should be adequately stabilized so that the luminous intensity of the lamp can be maintained throughout the test to within the required accuracy for the work.

3.2.3. A useful check on the overall stability of the reflex photometer during a series of tests is to make periodic measurements of CIL values of a stable reference standard.

3.2.4. Another technique is to incorporate in the apparatus an auxiliary detector to check or monitor the output of the light source. Although the output from the auxiliary detector can be checked for any change in reading, a useful refinement is to use the output to alter electronically the sensitivity of the main reflex photometer head and compensate automatically for changes in the light output of the source.

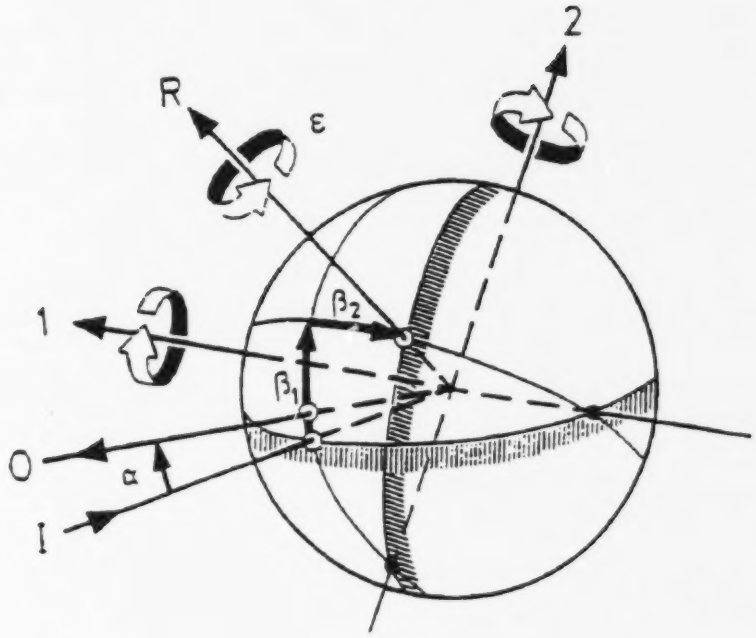


Figure 1

THE CIE CO-ORDINATE SYSTEM

1:	First Axis	I:	Illumination Axis	α:	Observation angle
2:	Second Axis	O:	Observation Axis	β_1, β_2:	Entrance angles
		R:	Reference Axis	ε:	Rotation angle

The CIE angular system for specifying and measuring retro-reflectors. The first axis is perpendicular to the plane containing the observation axis and the illumination axis. The second axis is perpendicular both to the first axis and to the reference axis. All axes, angles, and directions of rotation are shown positive.

Notes:
(a) The principle fixed axis is the illumination axis.
(b) The first axis is fixed perpendicular to the plane containing the observation and illumination axis.
(c) The reference axis is fixed in the retro-reflector and moveable with β_1 and β_2.

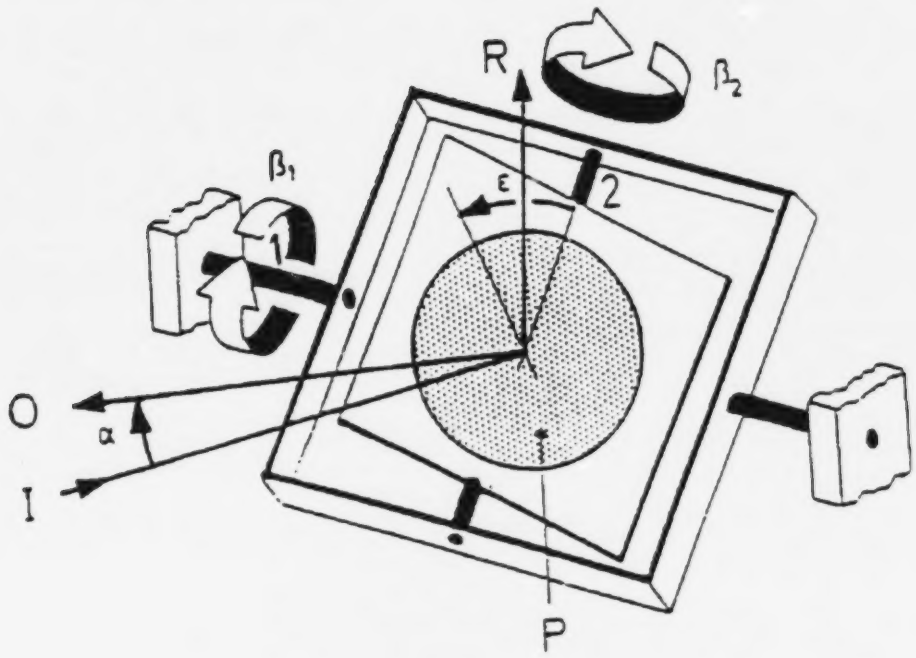


Figure 2

GONIOMETER MECHANISM EMBODYING THE CIE ANGULAR SYSTEM

1: First Axis	I: Illumination Axis	α:	Observation angle
2: Second Axis	O: Observation Axis	β_1, β_2:	Entrance angles
	R: Reference Axis	ϵ:	Rotation angle
	P: Retro-reflective material		

Representation of a Goniometer mechanism embodying the CIE angular system for specifying and measuring retro-reflectors. All angles and directions of rotation are shown positive.

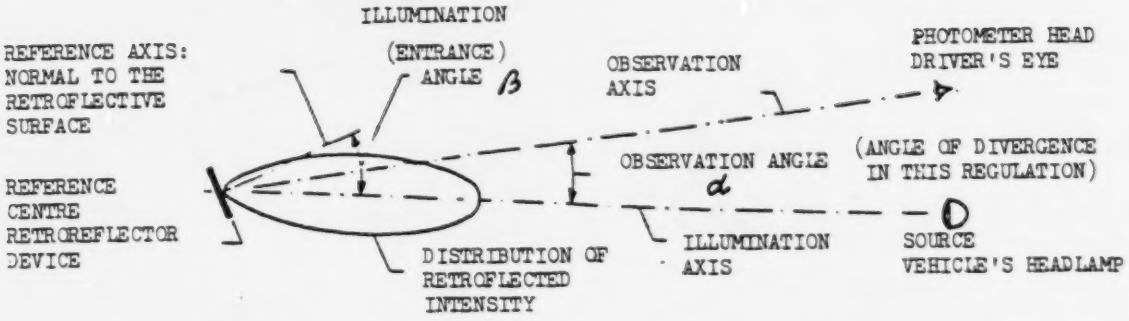
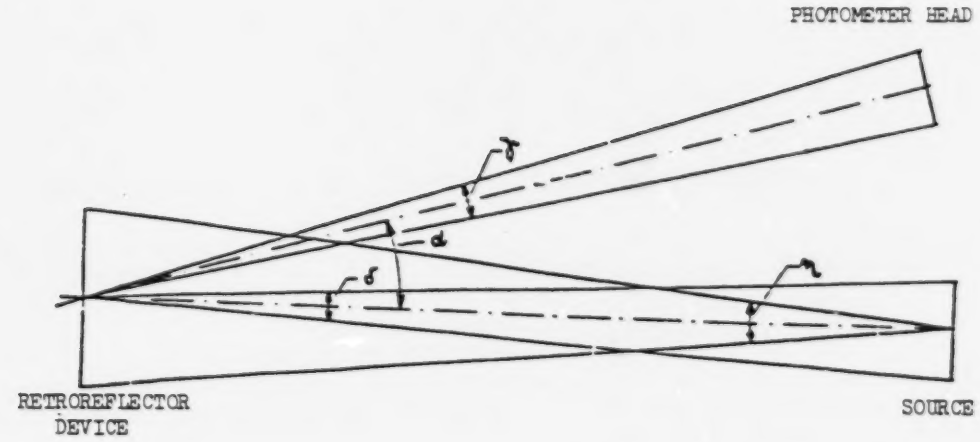


Figure 3



For the purpose of this Regulation, the following limits are set up:

$\delta \leq 10'$
$\gamma \leq 10'$
$\eta \leq 80'$

Figure 4

Annex 7

MINIMUM REQUIREMENTS FOR CONFORMITY OF PRODUCTION CONTROL PROCEDURES

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and geometric standpoint, if the differences do not exceed inevitable manufacturing deviations within the requirements of this Regulation.

1.2. With respect to photometric performances, the conformity of mass-produced advance-warning triangles shall not be contested if, when testing photometric performances of any advance-warning triangle chosen at random no measured value deviates unfavourably by more than 20 per cent from the minimum values prescribed in this Regulation.

1.3. The chromaticity coordinates shall be complied with.

2. MINIMUM REQUIREMENTS FOR VERIFICATION OF CONFORMITY BY THE MANUFACTURER

For each type of advance-warning triangle the holder of the approval mark shall carry out at least the following tests, at appropriate intervals. The tests shall be carried out in accordance with the provisions of this Regulation.

If any sampling shows non-conformity with regard to the type of test concerned, further samples shall be taken and tested. The manufacturer shall take steps to ensure the conformity of the production concerned.

2.1. Nature of tests

Tests of conformity in this Regulation shall cover the photometric and colorimetric characteristics, the test of weather resistance of these characteristics and the resistance to penetration of water.

2.2. Methods used in tests

2.2.1. Tests shall generally be carried out in accordance with the methods set out in this Regulation.

2.2.2. In any test of conformity carried out by the manufacturer, equivalent methods may be used with the consent of the competent authority responsible for approval tests. The manufacturer is responsible for proving that the applied methods are equivalent to those laid down in this Regulation.

2.2.3. The application of paragraphs 2.2.1. and 2.2.2. requires regular calibration of test apparatus and its correlation with measurements made by a competent authority.

2.2.4. In all cases the reference methods shall be those of this Regulation, particularly for the purpose of administrative verification and sampling.

2.3. Nature of sampling

Samples of advance-warning triangles shall be selected at random from the production of a uniform batch. A uniform batch means a set of advance-warning triangles of the same type, defined according to the production methods of the manufacturer.

The assessment shall in general cover series production from individual factories. However, a manufacturer may group together records concerning the same type from several factories, provided these operate under the same quality system and quality management.

2.4. Measured and recorded photometric characteristics

The sampled advance-warning triangle shall be subjected to photometric measurements at the points and the chromaticity coordinates provided for in the Regulation.

2.5. Criteria governing acceptability

The manufacturer is responsible for carrying out a statistical study of the test results and for defining, in agreement with the competent authority, criteria governing the acceptability of his products in order to meet the specifications laid down for verification of conformity of products in paragraph 10.1. of this Regulation.

The criteria governing the acceptability shall be such that, with a confidence level of 95 per cent, the minimum probability of passing a spot check in accordance with annex 8 (first sampling) would be 0.95.

Annex 8

MINIMUM REQUIREMENTS FOR SAMPLING BY AN INSPECTOR

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometric standpoint, in accordance with the requirements of this Regulation, if any, if the differences do not exceed inevitable manufacturing deviations.

1.2. With respect to photometric performance, the conformity of mass-produced advance-warning triangles shall not be contested if, when testing photometric performances of any advance-warning triangle chosen at random:

1.2.1. no measured value deviates unfavourably by more than 20 per cent from the minimum values prescribed in this Regulation.

1.2.2. Advance-warning triangles with apparent defects are disregarded.

1.3. The chromaticity coordinates shall be complied with.

2. FIRST SAMPLING

In the first sampling four advance-warning triangles are selected at random. The first sample of two is marked A, the second sample of two is marked B.

2.1. The conformity is not contested

2.1.1. Following the sampling procedure shown in Figure 1 of this annex the conformity of mass-produced advance-warning triangles shall not be contested if the deviation of the measured values of the advance-warning triangles in the unfavourable directions are:

2.1.1.1. sample A

A1:	one advance-warning triangle	0 per cent
	one advance-warning triangle not more than	20 per cent
A2:	both advance-warning triangles more than	0 per cent
	but not more than	20 per cent
	go to sample B	

2.1.1.2. sample B

B1:	both advance-warning triangles	0 per cent

2.2. The conformity is contested

2.2.1. Following the sampling procedure shown in Figure 1 of this annex the conformity of mass-produced advance-warning triangles shall be contested and the manufacturer requested to make his production meet the requirements (alignment) if the deviations of the measured values of the advance-warning triangles are:

2.2.1.1. sample A

A3:	one advance-warning triangle not more than	20 per cent
	one advance-warning triangle more than but not more than	20 per cent 30 per cent

2.2.1.2. sample B

B2:	in the case of A2	
	one advance-warning triangle more than	0 per cent
	but not more than	20 per cent
	one advance-warning triangle not more than	20 per cent
B3:	in the case of A2	
	one advance-warning triangle	0 per cent
	one advance-warning triangle more than	20 per cent
	but not more than	30 per cent

2.3. Approval withdrawn

Conformity shall be contested and paragraph 11. applied if, following the sampling procedure in Figure 1 of this annex, the deviations of the measured values of the advance-warning triangles are:

2.3.1. sample A

A4:	one advance-warning triangle not more than	20 per cent
	one advance-warning triangle more than	30 per cent
A5:	both advance-warning triangles more than	20 per cent

2.3.2. sample B

B4:	in the case of A2	
	one advance-warning triangle more than	0 per cent
	but not more than	20 per cent
	one advance-warning triangle more than	20 per cent
B5:	in the case of A2	
	both advance-warning triangles more than	20 per cent

B6:	in the case of A2	
	one advance-warning triangle	0 per cent
	one advance-warning triangle more than	30 per cent

3. REPEATED SAMPLING

In the cases of A3, B2, B3 a repeated sampling, third sample C of two advance-warning triangles and fourth sample D of two advance-warning triangles, selected from stock manufactured after alignment, is necessary within two months' time after the notification.

3.1. The conformity is not contested

3.1.1. Following the sampling procedure shown in Figure 1 of this annex the conformity of mass-produced advance-warning triangles shall not be contested if the deviations of the measured values of the advance-warning triangles are:

3.1.1.1. sample C

C1:	one advance-warning triangle	0 per cent
	one advance-warning triangle not more than	20 per cent
C2:	both advance-warning triangles more than	0 per cent
	but not more than	20 per cent
	go to sample D	

3.1.1.2. sample D

D1:	in the case of C2	
	both advance-warning triangles	0 per cent

3.2. The conformity is contested

3.2.1. Following the sampling procedure shown in Figure 1 of this annex the conformity of mass-produced advance-warning triangles shall be contested and the manufacturer requested to make his production meet the requirements (alignment) if the deviations of the measured values of the advance-warning triangles are:

3.2.1.1. sample D

D2:	in the case of C2	
	one advance-warning triangle more than	0 per cent
	but not more than	20 per cent
	one advance-warning triangle not more than	20 per cent

3.3. Approval withdrawn

Conformity shall be contested and paragraph 11. applied if, following the sampling procedure in Figure 1 of this annex, the deviations of the measured values of the advance-warning triangles are:

3.3.1. sample C

C3:	one advance-warning triangle not more than	20 per cent
	one advance-warning triangle more than	20 per cent
C4:	both advance-warning triangles more than	20 per cent

3.3.2. sample D

D3:	in the case of C2	
	one advance-warning triangle 0 or more than	0 per cent
	one advance-warning triangle more than	20 per cent

4. ADDITIONAL TESTS

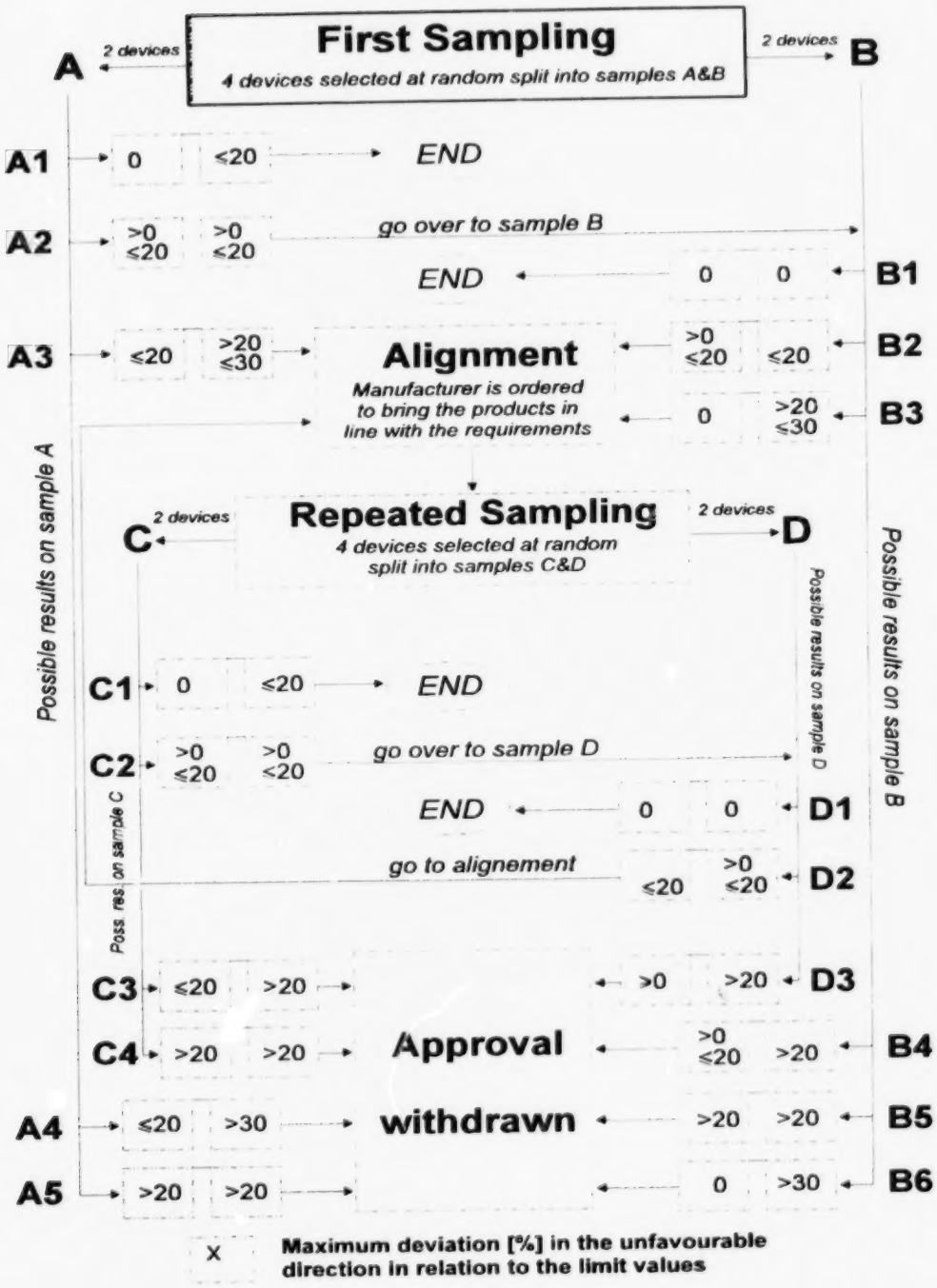
With respect to the verification of the normal use the following procedures shall be applied:

One additional advance-warning triangle shall be tested according to the procedures described in paragraph 1.5.3. to 1.8.3. of annex 5.

The advance-warning triangles shall be considered as acceptable if the tests have been passed.

However, if the test on this sample is not complied with, the two other additional advance-warning triangles shall be subjected to the same procedure and both shall pass the test.

Figure 1


First Sampling
4 devices selected at random split into samples A&B
A
2 devices
B
2 devices
A1
0
≤20
END
A2
>0 ≤20
>0 ≤20
go over to sample B
END
0
0
B1
A3
≤20
>20 ≤30
Alignment
Manufacturer is ordered to bring the products in line with the requirements
>0 ≤20
≤20
B2
0
>20 ≤30
B3
Possible results on sample A
Repeated Sampling
4 devices selected at random split into samples C&D
C
2 devices
D
2 devices
Possible results on sample B
Possible results on sample D
C1
0
≤20
END
C2
>0 ≤20
>0 ≤20
go over to sample D
END
0
0
D1
go to alignement
≤20
>0 ≤20
D2
Poss. res. on sample C
C3
≤20
>20
>0
>20
D3
C4
>20
>20
Approval
>0 ≤20
>20
B4
A4
≤20
>30
withdrawn
>20
>20
B5
A5
>20
>20
0
>30
B6
X
Maximum deviation [%] in the unfavourable direction in relation to the limit values